

The Present State and Future Perspective of Biomedical Engineering in Japan

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【 1 】 Introduction

Medicine has been directly involved with life of organisms, including humans as primary focus, with treatment or therapy as one of the important aims. An organism at any level of complexity possesses a variety of physiological functions. Understanding these biological functions and their complex and exquisite mechanisms is also another basic aim of medicine. Remarkable progress in medicine are made by introducing a variety of medical equipments including X-ray CT and NMR, and the medical application of computers and their network systems. Modern medicine and medical treatment cannot be fully utilized without these equipments. The development of these medical equipment and other biomaterials is engineering's contribution to medicine. On the other hand, understanding of the mechanisms of biological functions also leads to the creation of new technology. For instance, uncovering the mechanism of motion control by the central nervous system contributes to the development of a humanoid and FES. Results amassed from the interdisciplinary field of medicine and engineering are beneficial in the maintenance of life, in particular the human life, and improvement of the environment. It is said that the 21st century is a century of life sciences. Biomedical engineering is a field of integrated science and biotechnology, a paradigm where the basic agenda—namely, to understand, to defend , and to create life—should be carried out through cooperation between medicine and engineering.

The Japanese Society for Medical and Biological Engineering has aimed to develop technology which enables an ideal “symbiosis of biological organisms including humans and products of science and technology” , and has supported modern medicine and contributed to improving health, welfare and QOL of human beings, by cooperating with medical and biological societies in other countries belonging to IFMBE.

【 2 】 Present state of biomedical engineering in Japan

The Japanese Society for Medical and Biological Engineering was established in 1962 and has acted

as the base for the promotion of biomedical engineering and technological development in Japan. The number of members of the society was 900 at the time of establishment, but has increased to the present number of 4,000 people. The total number of researchers now exceeds 10,000, including scientists and engineers who belong to various societies such as the Society of Electronic, Information and Communication Engineers, the Society of Electric Engineers, the Society of Instrumentation and Automatic Control, and others related to the field of biomedical engineering. There are more than 600 presentations being made during the domestic annual conferences of our society. The conference has been held for 40 years now; we had the 40th meeting in Nagoya in May, this year, where the main theme was the IT revolution in BME. We also conduct meetings every autumn focusing on special topics in BME and other topics of particular interest to the participants. In winter, the ME forum is jointly organized with the Science Council of Japan, during which members have the opportunity to listen to the talk delivered by, for instance, the president of the Council as well as those presented by distinguished guest speakers from other societies related to biomedical engineering field. Our society publishes three journals, namely: the Journal of Medical Electronics and Biological Engineering, which is the official journal of the society; BME, an abbreviation of biomedical engineering, which enlightens the members about the present and future status of BME and other issues; and lastly, the Frontier of Biomedical Engineering, which is written in English.

The board of our society consists of 17 elected official members, the 10 chairmen of the special committees, and the leaders of the eight districts. The board members share various roles for the activities of the society.

【 3 】 Guideline and research projects of the JSMBE

The JSMBE has put up four issues as activity guidelines:

- (1) Promotion of basic research on biomedical engineering

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Promotion of the physiome project which takes a comprehensive review of the roles or functions of genes and their emergence in the entire individual / development to tissue engineering / promotion of visualization technique using PET and SPECT in molecular nuclear medicine

(2) Development and practical application of medical technology

Development of diagnostic equipment and treatment technology / optimal stimulus controller / intelligent biomaterial / consolidation of infrastructure of telemedicine or medicine for remote place and home health care system / strengthen the country's trade competitiveness of medical equipment industry / international standardization of medical equipment and biomaterials

(3) Solving social problems concerning medical treatments

Research and development of safe, effective and economically effective medical equipments and their assessment/medical ethics problems

(4) International contribution

Promotion of research and education of biomedical engineering in Asia/ human resource development / international contribution in medicine

JSMBE, in cooperation with the Japan academy, published a report and stated therein the promotion of the physiome project as a basic research, with eight emergent problems leading to practical applications listed as follows:

(1) instrumentation and signal processing

Non-invasive, non-contact depth information and physiological information measurement system, high technology in health and welfare instrumentation

(2) biomechanics and bio-mechanical engineering

Elucidation of remodeling mechanism, bio-tissue engineering, computational biomechanics, substitution physical exercise or support equipment, rehabilitation equipment, welfare apparatus

(3) biomaterials

Development of artificial organs and new biomaterials, bio-ceramics which may be a key to establish tissue engineering

(4) cell-tissue engineering

Substitution of transplant medicine by replacement therapy of defective functions, regenerated medicine by means of cell tissue engineering: biocompatibility, functionality, productivity, shelf life

Tissue engineering industry as a core of medical industry

(5) artificial organs

Implantation, biocompatibility, multiple-functionality, automatic controllability, high-permanence, hybridization, combined function, self-diagnosis and self-repairing, one touch wearability and exchangeability, heterotopic and distributed, soft and flexible, addition of non-biological functions

(6) medical imaging

High sensitivity and high resolution of diagnostic imaging apparatus such as clinical X-ray CT, MRI, ultrasonic diagnostic equipment, SPECT, PET etc.

(7) Treatment

Integration of internal medicine and surgery, low invasive celomic cure, promotion of telemedicine/home care, development of cancer radiotherapy apparatus, imaging technology, use of robot and computer in therapy, micro-machine, new biomaterials

(8) Medical information

Medical information and medical informatics / computational medicine, digital histomorphological database (visual human project, VHP) , unified medical language system (UMLS), medical knowledge network, genome informatics

In addition to these emergent agenda, I think that the promotion of the physiome project is very much important for the JSMBE. In fact, in Western countries it is considered that the physiome project may bring a big revolution in medical clinics and pharmaceutical processes. The physiome project is important not only in understanding the principle of life, but the outcome of the project is also directly related to practical applications that will be beneficial to the public. The physiome project is a comprehensive and gargantuan project; hence it is the one that the JSMBE should give priority to and be dealt with maximum effort. The JSMBE has

already made up a system to promote this project by working with the Japanese Society of Physiology, and the Japanese Pharmacological Society, as well as The Japanese Pharmacological Society.

Thus, biomedical engineering retains important, emergent and concrete agenda that concerns human health and welfare in the 21st century. To pursue these agenda in an efficient way, the JSMBE, together with other related societies, has also recommended to the Japanese Government the establishment of the Institute of Medical and Biological Engineering.

It is necessary to mention about the education and training of BME in Japan now being carried out in various universities and institutions. This will be reported in a different opportunity.

【 5 】 Movement for the establishment of the Institute for Medical and Biological Engineering

Just after its foundation in 1969, the JSMBE proposed a long-term research plan of the future prospect of the research in Biomedical Engineering. In 1970, a report was written on “the scheme, major research problems, education and training, and research institute for medical and biological engineering” under the support of the Monbusho Grant-in-Aid for Scientific Research. The sectional committee on medical and biological engineering was established by the National Committee for Electric Engineering during the 8th Science Council of Japan. This committee studied and discussed from all angles the above-mentioned reports and concluded that the academic scheme of the medical and biological engineering should be established. The committee started to look at the master plan for the establishment of the research institute from a broad perspective to provide a basis for long-term development of the BME field. It succeeded to get a consensus from the related fields and drew up the outline for the basic institute for biological engineering (tentative name). After careful deliberation, the Science Council of Japan accepted the outline and submitted a written advice for the establishment of the research institute to the Government.

After a small respite, in 1992, the JSMBE organized a special committee with the aim of establishing the Institute for Biomedical Engineering. In May, 2000, the Japan National Committee for Medical and Biological Engineering, the previous sectional committee on medical and biological engineering, together with The Japan National Committee for Research and Development

of Medical Instrumentation, and the JSMBE, submitted a formal report on the “Establishment of the Institute for Medical and Biological Engineering (tentative name)”. The JSMBE recommended also in a report the necessity of establishing the said institute. Prof. Kajiya, the former president of the JSMBE and the past president of IFMBE, introduced the NIH/BECON, now established as National Institute of Biomedical Imaging and Bioengineering (NIBIB). The idea of which must be closely related to the proposed institute. He also introduced the concept of physiome to our society for the first time and stressed the necessity for our society to start undertaking the physiome project. Recently, in 2001, the Medical Engineering Technology Industrial Strategy Consortium was founded through the coordination of the communities of the industry, government and academia. In September 1999, the IUPESM, the parent organization of IFMBE, was accepted to join the ICSU(International Council for Scientific Unions) as the 26th affiliated association. It was really good news not only for the JSMBE but also for other societies related to biomedical engineering and medicine.

In the present, the JSMBE, under the support of the related societies and associations, has continued the movement for the establishment of the Institute for Medical and Biological Engineering. However, the objection has not yet been fulfilled. We intend to tenaciously continue the movement to achieve its establishment.

【 6 】 Research Support System for the JSMBE

The Research Support System for the JSMBE is being improved. The Council for Science and Technology Policy, Cabinet Office of the Japanese Government, reported the second period grand plans of science and technology and decided to budget a total of 24 trillion yen to the plans for 5 years starting from the fiscal year 2001. The grand plans include an agenda on life science, in which the JSMBE is involved. There is also a grant source to the researchers of BME called the Grant-in-Aid from the Ministry of Education, Culture, Sports, Science and Technology. In addition to the grant, various research support systems involving several ministries are being constructed. The support system for the welfare engineering was established by NEDO (New Energy and Industrial Technology Development Organization, originally established in 1980) through the recommendation of the Health and

Welfare Technology Council. The Japan Science and Technology Corporation (JST) was created through the integration of two corporations on October 1, 1996 to enhance overall science and technology of Japan by organizing fundamental environment for scientific and technological information and by activating advanced and creative research and development. This organization has a program to support research on BME. As mentioned above, the Medical Engineering Technology Industrial Strategy Consortium was founded through the coordination of the communities of the industry, government and academia, by the initiative of the Ministry of

Economy, Trade and Industry. This consortium was created for the promotion of the Japanese-style BECON for enhancement of industrial technology of medical instruments and apparatuses and for strengthening the country's trade competitiveness. The Ministry of Health, Labor and Welfare also has its own support system.

The JSMBE needs to shape its goals according to the expectation and desire of the Japanese society as well the rest of humanity. The challenge of the JSMBE continues to shape the basis of tailored medicine in order to build a country that provides a safe, comfortable, and a high quality life.